

TF 2175

RF Power Amplifier

INSTRUCTION MANUAL



MARCONI INSTRUMENTS

RF Power Amplifier TF 2175

Code No. 52175-301Y

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.

H 54881-030D:C1



1978

Made in USA

**MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND**

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Note...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ► ◄ to show the extent of the change. When a chapter is reissued the triangles do not appear.

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

NOTES AND CAUTIONS

SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that the supply fuse is connected in series with the brown (live) wire of the supply lead. If the equipment is connected to the supply via a two-pin plug, it will be possible for the fuse to become connected to the neutral side depending upon the orientation of the plug in its socket. In these circumstances certain parts of the instrument could remain at supply potential even after the fuse has ruptured.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

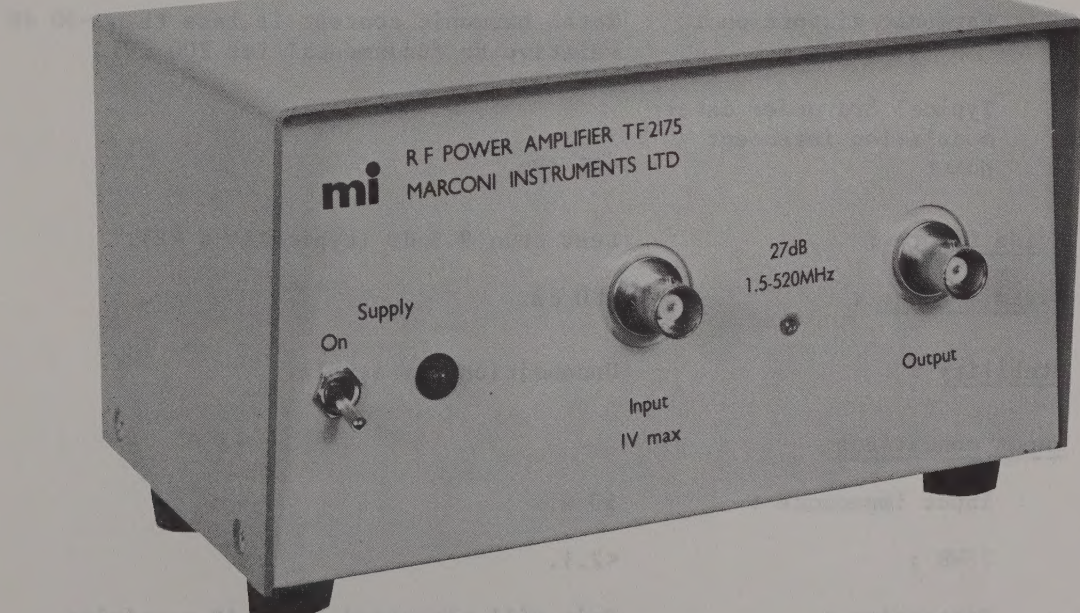
GENERAL INFORMATION

CONTENTS

INTRODUCTION

the frequency range 1.5 MHz to 520 MHz.

oscillation.



10-10-68

3. The TF 2175 with its wide frequency response and absence of any need to tune or readjust, provides a convenient means of extending the output power capability of signal generators, sweep generators and other signal sources. With its low noise linear class A design, the amplifier will operate over a wide range and faithfully reproduces pulse waveforms with rise times as short as 1 ns. Thus, the unit is ideally suited for a.m., f.m. and pulse modulation applications. The low noise figure and high output makes it ideal for the amplification and distribution of signals over long cables or through multi-coupler networks. As a drive source for aerials and in many applications such as r.f. interference and nuclear magnetic resonance, the unit will provide essentially constant forward power, regardless of transducer load impedance.

PERFORMANCE DATA

4. Frequency range

Bandwidth : 1.5 MHz to 520 MHz.

Response characteristics : Flat within ± 1 dB when feeding 50 Ω load.

Output level

Maximum linear power : >300 mW (24.8 dBm, 3.9 V across 50 Ω).

Input for 300 mW output : 0.6 mW (-2.2 dBm, 170 mV across 50 Ω).

Gain : 27 dB ± 1 dB (plus frequency response).

Output impedance : 50 Ω .

Signal purity

Harmonic distortion : Total harmonic content is less than -30 dB relative to fundamental (at 200 mW).

Typical 3rd order inter-modulation intercept point : +35 dBm.

Noise figure : Less than 9.5 dB (typically 8 dB).

Dynamic range : >80 dB.

Stability : Unconditionally stable.

Input conditions

Input impedance : 50 Ω .

VSWR : <2.1.

Protection : Unit will withstand a +14 dB overdrive (input signal of 1 V r.m.s.) for all output load conditions.

Connectors :

BNC.

Power requirements :115 V or 230 V a.c. $\pm 12\%$, 50 to 400 Hz,
12 W.Size and weight :

Height : 98 mm ($3\frac{1}{2}$ in).
 Width : 165 mm ($6\frac{1}{2}$ in).
 Depth : 112 mm ($4\frac{1}{2}$ in).
 Weight : 1.1 kg ($2\frac{1}{2}$ lb).

CONSTRUCTION

The 20 201 is housed in a rugged aluminium die-cast case, with front and rear panels forming part of the 19" mounting standard. The unit is pre-wired so that cables can be fitted to the back of the chassis.

20 201 VOLTAGE RATINGS

The 20 201 is a single channel unit, it is rated at 100 V a.c. and 12 W. and can be connected to the 230 V a.c. mains.

WEIGHT

The 20 201 is a single channel unit, it is rated at 100 V a.c. and 12 W. and can be connected to the 230 V a.c. mains. The unit is pre-wired so that cables can be fitted to the back of the chassis.

MAIN CASE

The main case of the 20 201 is made of aluminium die-cast, with front and rear panels forming part of the 19" mounting standard.

It is 19" high, 19" wide and 19" deep, with a weight of 1.1 kg.

The 20 201 is a single channel unit, it is rated at 100 V a.c. and 12 W. and can be connected to the 230 V a.c. mains.

MAIN LEAD CONNECTION

A single cable with a BNC connector is used to connect the unit to the 19" mounting standard. The cable is pre-wired so that it can be connected to the 230 V a.c. mains.

Chapter 2

INSTALLATION

CONTENTS

Para.

- 1 Construction
- 2 Mains voltage setting
- 4 Mains lead connection
- 5 Packaging for reshipment

CONSTRUCTION

1. The TF 2175 is housed in a hooded aluminium instrument case, the front and rear panels forming part of the 'U' section chassis. The unit is supported on four rubber feet fitted on the base of the chassis.

MAINS VOLTAGE SETTING

2. The supply voltage selection switch is located at the rear of the instrument and is normally set for 230 V a.c. operation.

CAUTION...

Before connecting the unit to the mains supply, check that the supply voltage selection switch is correctly set. Extensive damage will result if the amplifier is connected to the wrong supply voltage. Under no circumstances should this switch be operated whilst the supply is connected.

Mains fuse

3. The mains fuse F1 is located on the rear panel. The replacement part number and details are:-

0.5 A, Slow-blow, MI Part No. TF 2175/FPP 23401

The 0.5 A rating is correct for both 115 and 230 V a.c. mains working.

MAINS LEAD CONNECTION

4. A suitable mains supply plug must be fitted to the mains lead attached to the instrument. The three conductors are colour coded according to the international standards as follows:-

Brown	- LIVE
Blue	- NEUTRAL
Green/Yellow	- EARTH

PACKAGING FOR RESHIPMENT

5. In the event of the equipment being returned for servicing it should be packed in the original shipping carton and packing material. If this is not available wrap the instrument in heavy paper or plastic and place in a rigid outer box of wood, fibre-board or very strong corrugated cardboard. Use ample soft packing to prevent movement. Provide additional support for projecting parts to relieve these of unnecessary shock. Close the carton securely and seal with durable tape. Mark the shipping container FRAGILE to ensure careful handling.

Chapter 3

OPERATION

CONTENTS

Para.

- 1 Introduction
- 2 Operating procedure
- 3 Output capability of TF 2175
- 4 Load impedance
- 6 Distortion level
- 11 Noise figure

INTRODUCTION

1. The TF 2175 is used to increase the r.f. output level of signal sources in the 1.5 to 520 MHz range. No tuning or any other form of adjustment is required other than the selection of the correct power supply input voltage. The amplifier is unconditionally stable and can be connected into any load impedance with absolute protection against damage or oscillation.

OPERATING PROCEDURE

2. Check the voltage setting and fuse rating as described in Chap. 2, then proceed as follows:

- (1) Ensure the input voltage is not excessive.

CAUTION...

The 1 V indicated maximum input voltage is five times the level of the input signal (170 mV r.m.s.) required to achieve maximum output (300 mW). Input voltages in excess of 1 V may permanently damage the instrument.

- (2) Connect the input signal via a 50 Ω coaxial lead and BNC plug to the INPUT socket.
- (3) Connect the OUTPUT socket via a 50 Ω coaxial lead and BNC plug to the load. Para. 3 gives advice in determining output power capability.

OUTPUT CAPABILITY OF TF 2175

3. The power output capability of an amplifier is meaningful only when the output load impedance and distortion level specifications are also considered.

Load impedance

4. Output load impedance is not necessarily similar to output impedance and in the case of the TF 2175 is not related. The output load impedance refers to the optimum load impedance which, when connected to the amplifier output, will produce specified output power.

5. The TF 2175 produces the rated power output at the OUTPUT connector, regardless of load impedance. Any power reflected due to output load mismatch is absorbed in the amplifier. Therefore, although the output impedance is 50 Ω (typical v.s.w.r. 2:1), the amplifier will work into any load impedance.

Distortion level

6. There are two types of distortion which must be considered when using the TF 2175; they are 'total harmonic distortion' and 'intermodulation distortion'.

7. Total harmonic distortion is the sum of all the harmonics generated by the amplifier and is defined as:

$$\% \text{ THD} = \sqrt{E_2^2 + E_3^2 + E_4^2 + \dots} \times 100$$

$$\text{where } E_2 = \frac{\text{2nd harmonic voltage}}{\text{Fundamental voltage}}$$

$$E_3 = \frac{\text{3rd harmonic voltage}}{\text{Fundamental voltage}}$$

etc.

Therefore, if the total harmonic distortion is 6%, the power in all of the harmonics is 0.36% of the power in the fundamental. The 2nd harmonic is the highest level harmonic present at the output and is typically better than 30 dB down on the fundamental at 200 mW output.

Note...

Distortion level is strictly dependent on power output. The lower the power output, the lower the percentage distortion.

8. The 2nd harmonic distortion output decreases twice as fast as the fundamental power output, therefore at half power the 2nd harmonic is typically better than -36 dB relative to the fundamental.

9. Intermodulation distortion is the mixing products generated by the non-linear properties of an amplifier of a two-tone test signal. The 3rd order intermodulation intercept point is one method used to specify this type of distortion.

10. 3rd order intermodulation intercept point is the theoretical power level at which the 3rd order products of a two-tone test signal are equal to the test signal output (the amplifier would saturate before this point was reached). The TF 2175 has a 3rd order intermodulation intercept point of +35 dBm. This method is easier to use and more accurate than, say, the compression method.

Example:-

To calculate the maximum peak envelope power obtainable from a TF 2175 with intermodulation products not greater than 32 dB.

(1) Subtract half the acceptable intermodulation distortion from the intercept point.

$$+35 \text{ dBm} - \frac{32 \text{ dB}}{2} = 19 \text{ dBm}$$

(Remember the distortion power decreases twice as fast as the fundamental power decrease.)

(2) 19 dBm (79 mW) is the power in each signal. To convert to peak envelope power multiply by 4.

$$79 \text{ mW} \times 4 = 316 \text{ mW p.e.p.}$$

Noise figure

11. This is the noise contributed by the amplifier. The noise figure for the TF 2175 is less than 9.5 dB (typically <8 dB). This means that the equivalent noise at the input, P_e , is 9.5 dB higher than that produced by thermal energy, P_t (typically -92 dBm).

$$\begin{aligned} P_e &= P_t + 9.5 \text{ dB} \\ &= -92 \text{ dBm} + 9.5 \text{ dB} = -82.5 \text{ dBm} \\ &= 0.56 \times 10^{-11} \text{ W} \end{aligned}$$

Since the equivalent input noise is -82.5 dBm and the signal required for maximum output of 300 mW is -2.2 dBm, the dynamic range of the TF 2175 is -80.3 dBm.

12. Translation of noise figure into equivalent noise voltage (E_e) is as follows:-

$$\begin{aligned} E_e &= \sqrt{P_e R} \\ &= \sqrt{0.56 \times 10^{-11} \times 50} \text{ V} \\ &= \sqrt{280 \times 10^{-12}} \text{ V} \\ &= 16.7 \text{ } \mu\text{V} \end{aligned}$$

Chapter 4

TECHNICAL DESCRIPTION

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Para.

- 1 RF stages
- 3 Power supply

RF STAGES

1. The TF 2175 is designed to amplify signals by 27 dB in the frequency band 1.5 to 520 MHz. The signal from the front panel BNC connector is fed via a length of micro-strip transmission line to a π network attenuator R6, R7 and R8. The attenuator is adjusted during alignment to ensure that the gain of the amplifier is 27 dB.

2. The output from the attenuator is then fed via impedance matching transformer T2 to a thin film amplifier module ENI 802B which has been specially developed for this instrument. The ENI 802B consists of a four transistor circuit mounted on a 12.5 x 25 mm alumina substrate. The transistor chips are bonded to 'heat spreaders' to reduce their operational temperature and therefore permit higher power output. All the amplifier components are mounted on the substrate of the module package except for r.f. chokes L1, L2 and L3. The output of the amplifier is coupled through C5 and fed via a length of microstrip to the output BNC connector.

POWER SUPPLY

3. The TF 2175 power requirements are 115 V or 230 V a.c. The power supply unit provides a 24 V d.c. 300 mA source, regulated by the series pass transistor Q2 and integrated circuit regulator Q3 mounted on the mother board, adjacent to the amplifier module. R7 adjusts the d.c. rail to 24 V. The light emitting diode D1, connected to the regulated output and mounted on the front panel, indicates when the power supply is operating.

Chapter 5

MAINTENANCE

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Para.

- 1 Introduction
- 4 Access and layout
- 5 Test equipment
- 6 Performance tests
- 9 Realignment procedure
- 10 Measurement of gain
- 11 Measurement of harmonics
- 12 Measurement of power output

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INTRODUCTION

1. The TF 2175 requires no periodic maintenance. The instrument is unconditionally stable and is therefore 'fail-safe' under all load conditions. Damage can only be caused by the incorrect selection of the supply voltage or by an input signal in excess of the specified 1 V maximum. This chapter therefore deals only with certain fundamental procedures for fault location and with the subsequent re-alignment procedures.

2. Performance limits quoted are for guidance only and should not be taken for guaranteed performance specifications unless they are also quoted in the Performance Data in Chap. 1.

3. In case of difficulties which cannot be resolved with the aid of this manual, please contact our Service Division at the address stated on the back cover, or your nearest Marconi Instruments representative quoting the type and serial number of the instrument. If the instrument is being returned for repair, please indicate clearly the nature of the fault or the work you require to be done.

ACCESS AND LAYOUT

4. The instrument is housed in a hooded aluminium case, the front and rear panels forming part of the 'U' section chassis. The hooded cover can be detached by releasing the four 4-40 ANC Phillips headed screws located on the sides of the instrument. The rear panel supports the mains fuse unit and the mains input voltage selector switch S2 and also acts as a heat sink for integrated circuit Q1.

CAUTION...

Do not remove the amplifier and module retaining screws, as the units must be precisely aligned for proper mechanical fit.

TEST EQUIPMENT

5. The test equipment required for checking and realigning the instrument is listed in Table 1.

Note...

When making tests to verify that the instrument meets the stated performance limits allowance must always be made for the uncertainty of the test equipment used.

TABLE 1 TEST EQUIPMENT

Item	Description	Recommended model
a	Multimeter	
b	Oscilloscope	
c	Spectrum analyser	
d	Calorimetric power meter	
e	Sweep generator, u.h.f.	MI TF 2361 with plug-ins TM 9693 & TM 9694
f	Detector, u.h.f.	MI TM 9701
g	X-Y display	MI TF 2212A
h	Signal generator, v.h.f., 50 Ω	
i	RF millivoltmeter, u.h.f.	MI TF 2603
j	1 W 20 dB attenuator	MI 54431-011
k	Coaxial T connector	MI TM 7948
l	Signal generator, u.h.f.	MI TF 801D/1
m	Power meter, 3 W, u.h.f.	MI TF 2501

PERFORMANCE TESTS

Test equipment : items a, b, c, d & e.

6. The following check can be made following repair and adjustments or whenever the condition of the unit is in question.

- (1) Connect the power supply. Switch on and observe that the supply lamp D1 illuminates.
- (2) Connect a sweep generator capable of sweeping the frequency range 1.5 to 520 MHz to the INPUT connector.
- (3) Adjust the output level of the sweep generator so that a 50 Ω video detector connected at the output of the TF 2175 will not be damaged by excessive power output.
- (4) Observe the gain versus frequency ripple on an oscilloscope calibrated in decibels. The gain variation must be not more than ± 1 dB over the frequency range.
- (5) Connect a calorimetric power meter through a short length of 50 Ω cable to the OUTPUT connector. Adjust the input c.w. signal at any frequency between 1.5 and 520 MHz for 200 mW output.
- (6) Observe the harmonic distortion of the output on a spectrum analyser. The harmonic components contributed by the amplifier must be more than 30 dB down from the fundamental.

7. If the requirements of this check are not met, verify that:

- (1) The mains supply switch and fuse are correctly selected and that D1 is illuminated.
- (2) The power amplifier supply voltage is set at 24 V by R3.

8. If the above checks are found to be correct, then normal fault location procedures, with reference to the circuit diagram in Chap. 7 should be followed to determine the correct operation of the ENI 802B module. If the module is found to be faulty it will be necessary to obtain a replacement module from our Service Division or return the complete unit for repair. Replacement of the module or any other part of the signal line will require the instrument to be re-aligned.

REALIGNMENT PROCEDURE

9. Before any adjustment is made to the TF 2175, first :

- (1) Ensure that the mains switch and fuse are correctly selected and that D1 is illuminated.
- (2) Measure the voltage at Q2 emitter and adjust for 24 V.

Measurement of gain

Test equipment : items e, f & g.

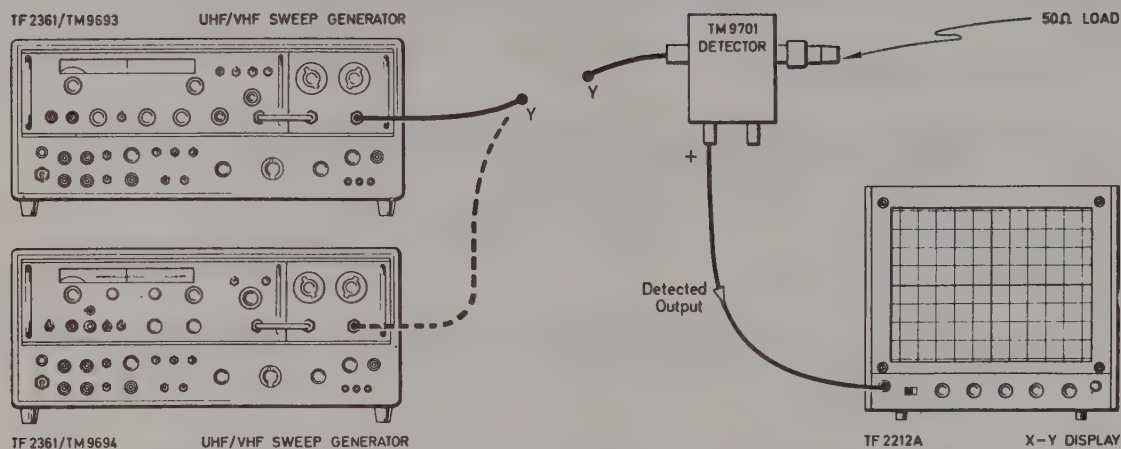


Fig. 1 Gain measurement

10. Connect the equipment as shown in Fig. 1, then proceed as follows:-

- (1) Adjust the sweep generator (with v.h.f. sweep unit fitted) to sweep 1.5 MHz to 220 MHz, in c.w. mode and with the output set at 0 dB.
- (2) Align the X-Y display to one of the centre graticule lines. Check the flatness of the response, noting the low and high extremes, their frequency and level.
- (3) Reduce the output of the sweep generator by 27 dB using the calibrated attenuator.
- (4) Insert the TF 2175 at points Y-Y and observe the X-Y display which should be centred on the original line in (2). This is the amplifier gain and should be within 27 dB $\pm$ 1 dB.
- (5) Determine and record the lowest and highest peaks, allowing for the variations observed in (2) and also note the level at 220 MHz.
- (6) Replace the v.h.f. unit with the u.h.f. unit. Repeat checks (1) to (5) for the frequency band 220 MHz to 520 MHz, ensuring that the level indicated at 220 MHz is the same as that recorded in check (5) using the v.h.f. unit.
- (7) Check that the lowest and highest peaks over the whole frequency range of 1.5 to 520 MHz does not differ by more than 1 dB from the amplifier gain determined in check (4).
- (8) Repeat (1) to (5).

Measurement of harmonics

Test equipment : items e, h, i, j & k.

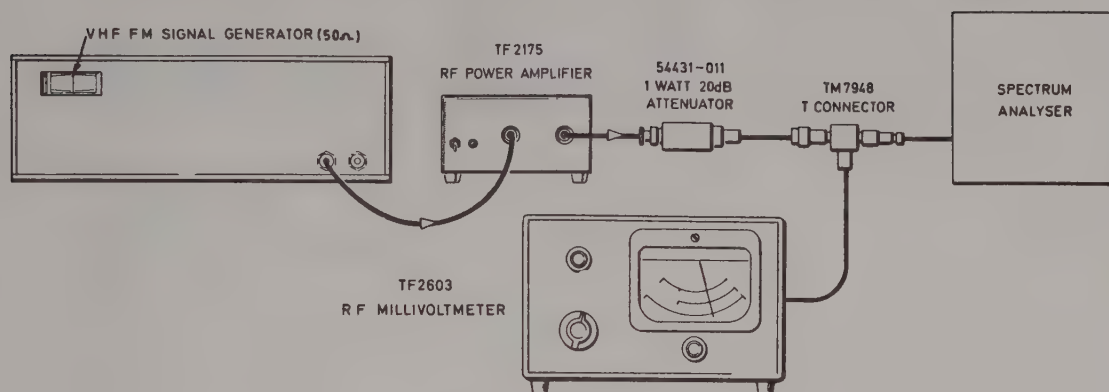


Fig. 2 Harmonic measurement

11. Connect the equipment as shown in Fig. 2 and then proceed as follows:-

- (1) Adjust the signal generator at 150 MHz for an indicated output of 316 mV on the millivoltmeter.
- (2) Using the spectrum analyser check that the total level of the carrier harmonics is less than -30 dB with respect to the carrier. If not the 24 V d.c. supply may be varied by up to 0.5 V to reduce the harmonic level in which case the gain must be rechecked.

Measurement of power output

Test equipment : items i, k, l & m.

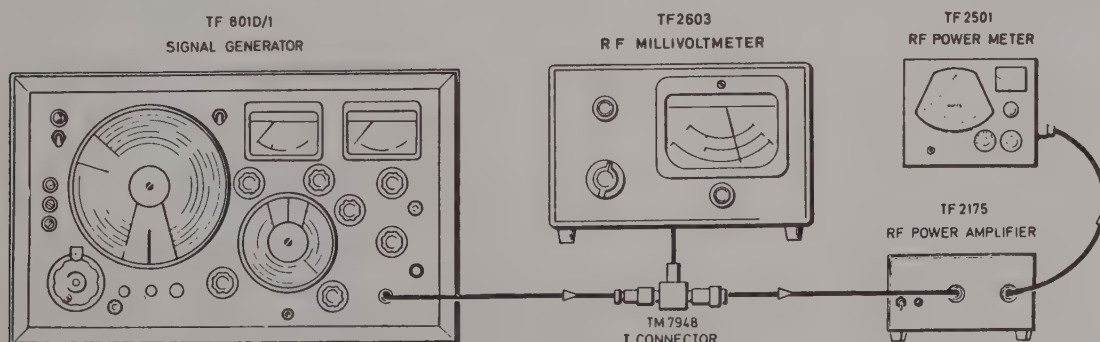


Fig. 3 Power output measurement

12. Connect the equipment as shown in Fig. 3 and proceed as follows:-

(1) Adjust the output of the signal generator to 500 mV at 200 MHz and check that the power meter indicates an output from the TF 2175 of greater than 300 mW.

(2) Reduce the output of the signal generator until the power meter just indicates 300 mW. Ensure that the output of the signal generator as indicated on the millivoltmeter is approximately 170 mV.

Chapter 6

REPLACEABLE PARTS

CONTENTS

Para.

- 1 Introduction
- 2 Ordering
- 3 Electrical components

INTRODUCTION

1. The circuit reference numbers are listed in alpha-numerical order. The following abbreviations are used:-

C	: Capacitor	L	: Inductor
CR	: Bridge rectifier	Q	: Transistor or integrated circuit
D	: Diode	R	: Resistor
Elec	: Electrolytic	S	: Switch
F	: Fuse	T	: Transformer
IC	: Integrated circuit	W	: Watts
J	: Connector		

ORDERING

2. When ordering replacements or spare parts, address your order to :

Marconi Instruments Service Division,
The Airport,
Luton, Bedfordshire.

or to your nearest representative. Please specify the following information for each part required.

- (1) Type of instrument.
- (2) Circuit reference number.
- (3) Description of part.
- (4) MI part number.

ELECTRICAL COMPONENTS

3. <i>Circuit reference</i>	<i>Description</i>	<i>MI part number (TF 2175/FPP.....)</i>
C1	500 μ F 50V Elec	26006
C2	560pF 500V d.c. Ceramic	26008
C3	0.1 μ F 50V d.c. Ceramic	26009
C4	0.1 μ F Ceramic	26007
C5	0.012 μ F Ceramic	26003
CR1	2A 75V p.i.v.	28102
D1	Pilot lamp (LED)	28101
F1	0.5A 3AG slow-blow	23401
IC1	RC723T (Voltage regulator)	28402
J1	BNC socket (INPUT)	23001
J2	BNC socket (OUTPUT)	23001
L1	ENI 10226	43201
L2	ENI 10226	43201
L3	ENI 10226	43201
Q1	ENI 802B (Amplifier module)	28403
Q2	40312	28201
R1	150k Ω $\pm$ 5% 1/4W	24006
R2	6.8k Ω $\pm$ 5% 1/2W	24004
R3	200 Ω variable 1/2W	25001
R4	2.7k Ω $\pm$ 5% 1/2W	24005
R5	2.2k Ω $\pm$ 5% 1/4W	24003
R6	12 Ω $\pm$ 5% 1/4W	24002
R7,R8	390 Ω $\pm$ 5% 1/4W	24001
S1	SPDT toggle (POWER)	23101
S2	DPDT slide (230/115 V)	23102
T1	AM 6400A (Mains) 117-234V a.c.	43101

Chapter 7

SERVICING DIAGRAMS

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- 1 Circuit notes
- 2 Symbols

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CIRCUIT NOTES

Component values

- 1. Resistors : No suffix = ohms, k = kilohms, M = megohms.
Capacitors : No suffix = microfarads, p = picofarads.

Symbols

- 2. 50 Ω : micro-strip transmission line.

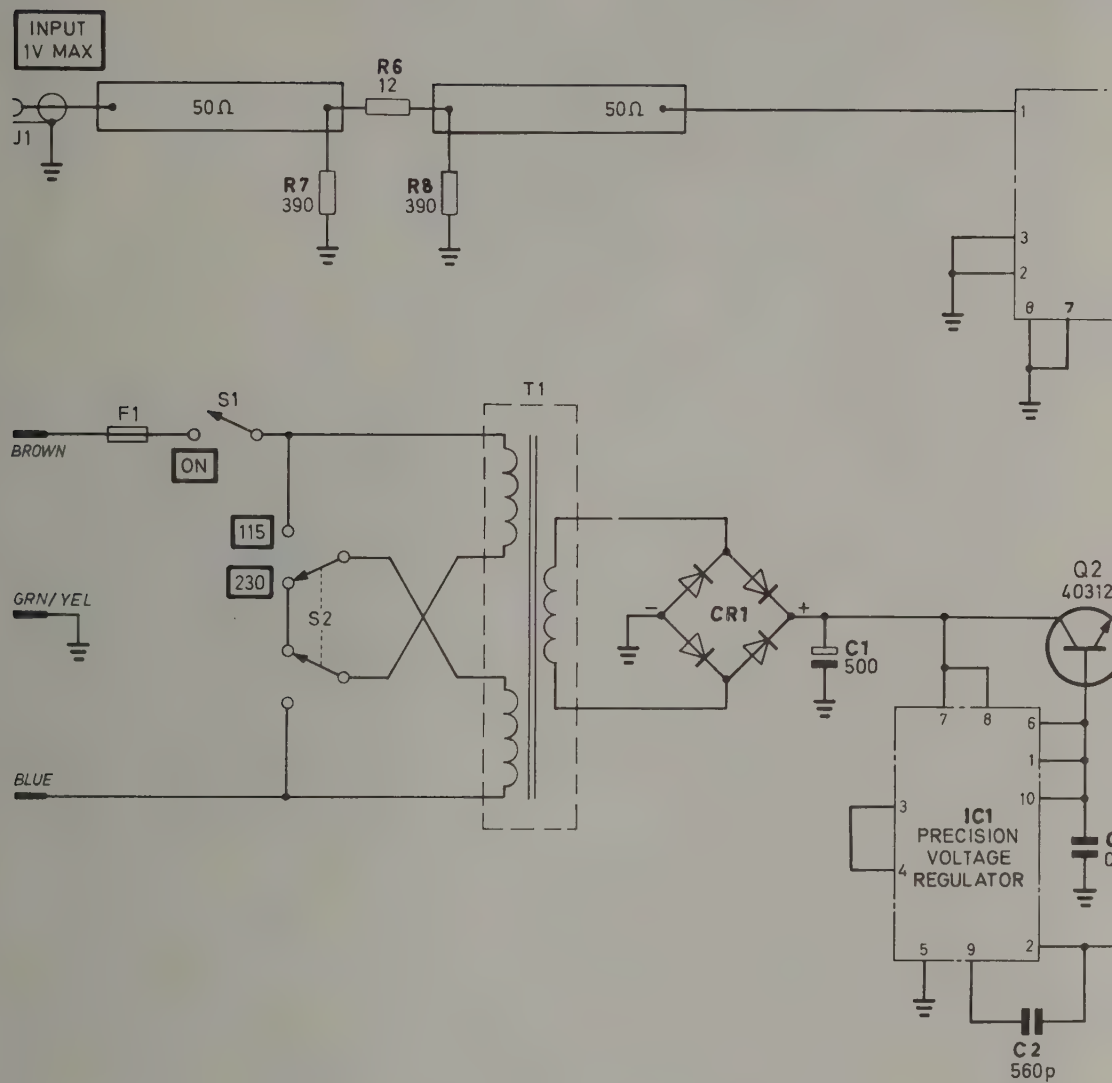
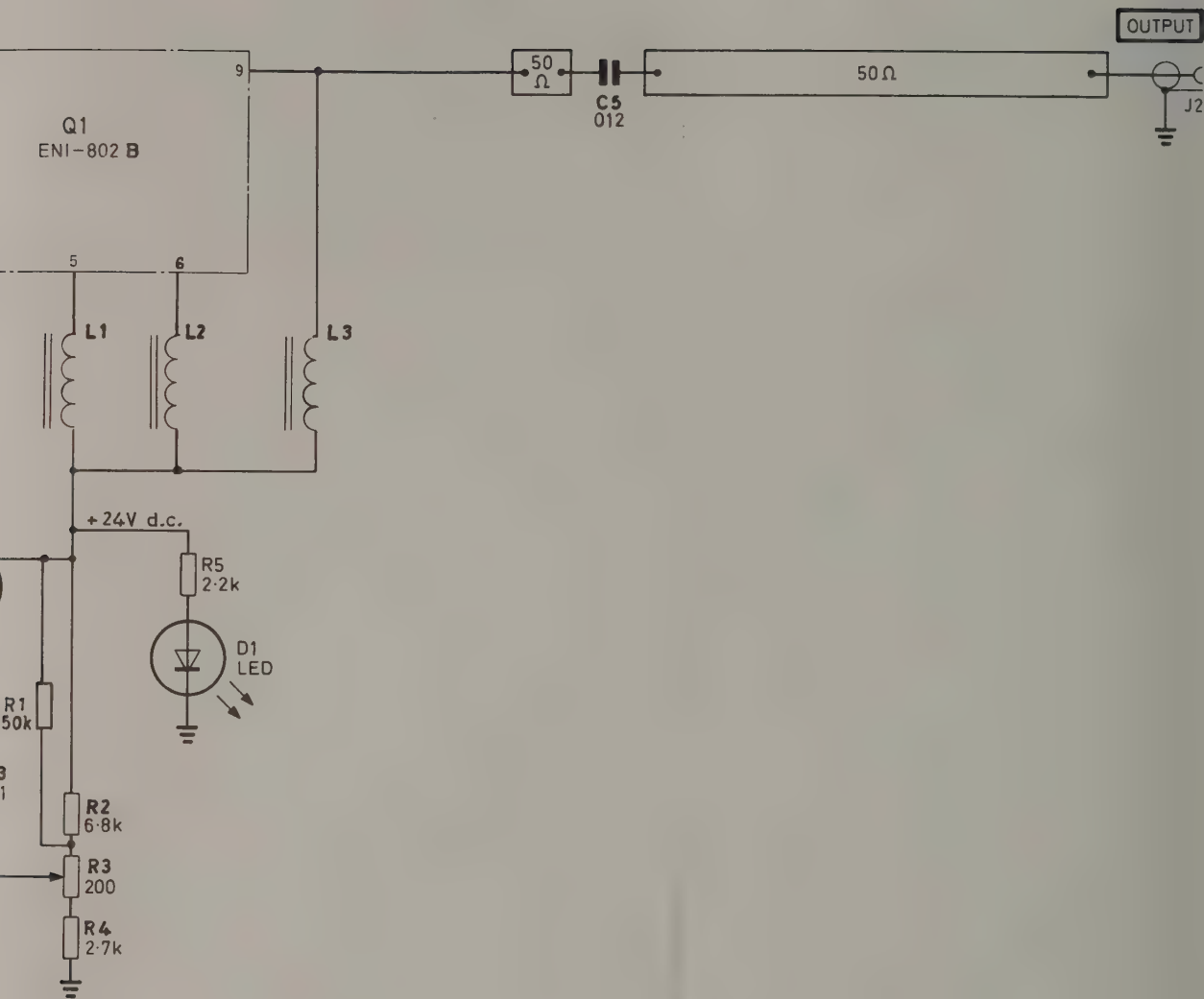


Fig. 1

TF 2175 RF Power A



amplifier circuit diagram

BNC.

Connectors :

Power requirements :

115 V or 230 V a.c. $\pm 12\%$, 50 to 400 Hz,
12 W.

Size and weight :

Height : 98 mm (3 $\frac{1}{2}$ in).
Width : 165 mm (6 $\frac{1}{2}$ in).
Depth : 112 mm (4 $\frac{1}{2}$ in).
Weight : 1.1 kg (2 $\frac{1}{2}$ lb).



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